UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/811,186	03/26/2004	Zhen-Cheng Wu	252011-2150	2952

47390 7590 05/17/2006

THOMAS, KAYDEN, HOSTEMEYER & RISLEY LLP
100 GALLERIA PARKWAY
SUITE 1750
ATLANTA, GA 30339

EXAMINER	
BLUM, DAVID S	

ART UNIT	PAPER NUMBER
2813	

DATE MAILED: 05/17/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/811,186	WU ET AL.	
	Examiner	Art Unit	
	David S. Blum	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *10 February 2006*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *18-41* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *18-26,28-39 and 41* is/are rejected.

7)☒ Claim(s) *27 and 40* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

This is in response the election filed 2/10/06.

DETAILED ACTION

Election/Restrictions

1. Applicant's election without traverse of claims 18-41 in the paper filed 2/10/06 is acknowledged. Further, 5the applicant has elected to prosecute the following species: P-Silk as the oxygen free species, copper as the conductive line species, copper as the conductive plug species, silicon oxycarbide as the dielectric barrier and as the first dielectric layer or oxygen containing etch stop.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claims 19 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 19 recites "and the dielectric barrier" in claim 18, but it is unclear which dielectric barrier "the" refers to.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. Claims 18-20, 24-25, 28-33, 37-38, and 41 are rejected under 35 U.S.C. 102(b) as being anticipated by Lee (US 6492256).

Lee teaches the device of claims 18-20, 24-25, 28-33, 37-38, and 41 as follows.

Regarding claim 18, Lee teaches a dielectric barrier (52) on a semiconductor substrate (50), a plurality of stacked structures (86 and 86) comprising a conductive line (54) and a conductive plug (fill of gap 66, column 7 lines 7-8), a conformal dielectric layer (88) on the surfaces of the stacked layer, and a second dielectric layer (also 88) on the first layer. As there is no differentiation between the two dielectric layers, one layer may be considered the same as two layers.

Regarding claim 19, the etching stop layer (62) is between the substrate and the dielectric barrier. Etch stop layer 90 also reads on this claim.

Regarding claim 20, the etch stop layer comprises oxygen containing material (column 5 lines 49-51).

Regarding claim 24, the conductive layer comprises copper (column 4 line 49).

Regarding claim 25, the conductive plug comprises copper (see claim 5).

Regarding claim 28, the interconnect structure comprises at least one air gap between the stacked layers (air gap 100).

Regarding claim 29, Lee teaches a semiconductor substrate (50), a pair of stacked structures (86 and 86) comprising a conductive line (54) and a conductive plug (fill of 66, column 7 lines 7-8), and a conformal dielectric layer (88) disposed along the sidewalls of each stacked structure.

Regarding claim 30, a second dielectric layer (also 88) is on the first layer. As there is no differentiation between the two dielectric layers, one layer may be considered the same as two layers.

Regarding claim 31, the dielectric layer is disposed along the substrate between the stacked structures.

Regarding claim 32, the etching stop layer (62) is between the substrate and the dielectric barrier. Etch stop layer 90 also reads on this claim.

Regarding claim 33, the etch stop layer comprises oxygen containing material (column 5 lines 49-51).

Regarding claim 37, the conductive layer comprises copper (column 4 line 49).

Regarding claim 38, the conductive plug comprises copper (see claim 5).

Regarding claim 41, the interconnect structure comprises at least one air gap between the stacked layers (air gap 100).

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. Claims 22-23 and 35-36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee (US 6,492,256) in view of Zhou (US 6,358,842).

Lee teaches the device of claims 22-23 as recited above in regard to claim 18, and of claims 35-36 as recited above in regard to claim 29, except for the use of P-Silk.

Regarding claim 22, Zhou teaches an oxygen free dielectric layer as the first dielectric layer (SILK column 4 line 37). The purpose of using a low dielectric constant material is to lower capacitance loading and coupling problems (column 4 lines 20-24).

Regarding claim 23, Zhou teaches an oxygen free dielectric layer of SILK (column 4 line 37). The purpose of using a low dielectric constant material is to lower capacitance loading and coupling problems (column 4 lines 20-24).

Regarding claim 35, Zhou teaches an oxygen free dielectric layer as the first dielectric layer (SILK column 4 line 37). The purpose of using a low dielectric constant material is to lower capacitance loading and coupling problems (column 4 lines 20-24).

Regarding claim 36, Zhou teaches an oxygen free dielectric layer of SILK (column 4 line 37). The purpose of using a low dielectric constant material is to lower capacitance loading and coupling problems (column 4 lines 20-24).

One skilled in the requisite art would modify Lee by using a low dielectric constant material such as SILK as taught by Zhou, as the purpose of using a low dielectric constant material is to lower capacitance loading and coupling problems (column 4 lines 20-24).

8. Claims 21 and 26 and 34 and 39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee (US 6,492,256) in view of Tsai (US 6,943,391).

Lee teaches the device of claims 21 and 26 as recited above in regard to claim 18, and of claims 34 and 39 as recited above in regard to claim 29, except for the use of silicon oxycarbide as the etch stop layer.

Regarding claim 21, Lee teaches an etch stop layer of (silicon) nitride, silicon oxynitride, and silicon carbide (column 5 lines 49-51). Tsai also teaches the etch stop layer to be silicon nitride, silicon oxynitride, and silicon carbide, and additionally teaches it may be silicon oxycarbide (column 3 lines 29-31), thus teaching an art recognized equivalence.

Regarding claim 26, as the materials are identical, one would, with reasonable optimization, obtain the same dielectric constant of claim 26.

These ranges are considered to involve routine optimization while it has been held to be within the level of ordinary skill in the art. As noted in In re Aller (105 USPQ233), the selection of reaction parameters such as temperature and concentration would have been obvious:

> "Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art. Such ranges are termed "critical ranges and the applicant has the burden of proving such criticality.... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."
>
> In re Aller 105 USPQ233, 255 (CCPA 1955). See also In re Waite 77 USPQ 586 (CCPA 1948); In re Scherl 70 USPQ 204 (CCPA 1946); In re Irmscher 66 USPQ 314 (CCPA 1945); In re Norman 66 USPQ 308 (CCPA 1945); In re Swenson 56 USPQ

372 (CCPA 1942); In re Sola 25 USPQ 433 (CCPA 1935); In re Dreyfus 24 USPQ 52 (CCPA 1934).

One skilled in the requisite art at the time of the invention would have used any ranges or exact figures suitable to the method in the process of regarding dielectric constants using prior knowledge, experimentation, and observation with the apparatus used in order to optimize the process and produce the structure desired to the parameters desired.

Regarding claim 34, Lee teaches an etch stop layer of (silicon) nitride, silicon oxynitride, and silicon carbide (column 5 lines 49-51). Tsai also teaches the etch stop layer to be silicon nitride, silicon oxynitride, and silicon carbide, and additionally teaches it may be silicon oxycarbide (column 3 lines 29-31), thus teaching an art recognized equivalence.

Regarding claim 39, as the materials are identical, one would, with reasonable optimization, obtain the same dielectric constant of claim 26. this is optimization as above.

One skilled in the requisite art would modify Lee by using silicon oxycarbide as taught by Tsai to be an art recognized equivalence to the etch stop layers used by Lee.

Allowable Subject Matter

9. Claims 27 and 40 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the

limitations of the base claim and any intervening claims. Claims 27 and 40 limit the upper portion of the conformal dielectric layer to being a second dielectric layer of a different dielectric constant than the lower layer.

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to David S. Blum whose telephone number is (571)-272-1687) and e-mail address is David.blum@USPTO.gov .

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead Jr., can be reached at (571)-272-1702. Our facsimile number all patent correspondence to be entered into an application is (571) 273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

David S. Blum

May 15, 2006